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Efficacy of Laser-assisted Uvulopalatoplasty

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Background and Objective: **Laser-assisted uvulopalatoplasty (LAUP) is being used increasingly as a surgical treatment for snoring and obstructive sleep apnea (OSA). There is limited evidence for the success of LAUP in eliminating OSA. This study assesses the efficacy of LAUP in eliminating snoring and OSA and addresses which patients may be the best candidates for LAUP treatment.**
Study Design/Materials and Methods: **From January 1994 to January 1996, 297 patients were evaluated for snoring, with 190 (64%) exhibiting some degree of OSA documented by a PSG: 41/190 (22%) mild OSA; 33/190 (17%) moderate OSA; 85/190 (45%) severe OSA; 31/190 (16%) severity unknown. Ninety patients (90/297) have undergone LAUP treatment: 58/90 (64%) with OSA and 32/90 (36%) with snoring only.**
Results: **Our results indicate a significant reduction of snoring in patients without OSA, but diminishing success in patients with increasing degrees of OSA. Additionally, LAUP was not efficacious in treating OSA: pre-op respiratory disturbance index (RDI) of 10.8 vs. post-op RDI of 19.5 for mild OSA ($P = 0.14$); pre-op RDI of 22.9 vs. post-op RDI of 25.4 for moderate OSA ($P = 0.43$); pre-op RDI of 56.8 vs. post-op RDI of 46.3 ($P < 0.05$), which is *statistically* but not *clinically* significant (i.e., RDI remained in the severe range).**
Conclusion: **We conclude that LAUP is an effective treatment for nonapneic snoring, but does not provide sufficient resolution of OSA, and based on our results, LAUP should be considered as an adjunctive therapy rather than a sole treatment for OSA in most cases. Lasers Surg. Med. 21:109–116, 1997.** **© 1997 Wiley-Liss, Inc.**

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Key words: apnea; apnea index; hypopnea; hypopnea index; nonapneic snoring; obstructive sleep apnea (OSA); polysomnogram (PSG); respiratory disturbance index (RDI); snoring; uvulopalatopharyngoplasty (UPPP)

INTRODUCTION

Habitual loud snoring which occurs in 20–25% of adults [1], has gained increasing attention for its socially disruptive effects. More importantly, snoring may indicate the presence of obstructive sleep apnea (OSA), estimated to affect 4% of adults [2]. OSA poses significant risks associated with hypertension, cardiac dysrhythmias, stroke, and increased mortality [3].

Numerous treatment options are available for snoring and OSA. Nonsurgical measures, including weight loss, sleep positioning, and avoidance of alcohol, tobacco, and certain drugs, are helpful, although often not curative alone. Mechanical ventilation via continuous or biphasic positive airway pressure (CPAP or BiPAP) is the mainstay of nonsurgical therapy for OSA. Although also effective for snoring, compliance with CPAP in the "snoring-only" population is poor [4]. Dental prostheses (mandible advancement prostheses and tongue restraining devices) have shown increasing success with snoring and OSA [5,6].

Surgical measures for treatment of snoring and OSA include nasal airway procedures, partial palatal resection, tongue base resection, orthognathic procedures, and finally tracheotomy. Much controversy has arisen over appropriate use of these procedures given the morbidity associated with more aggressive but successful approaches (i.e., tongue base and orthognathic procedures and tracheotomy) versus less aggressive procedures whose impact on snoring may be far more efficacious then their impact on OSA (i.e., palatal and nasal surgery).

Palatal resection via uvulopalatopharyngoplasty (UPPP), introduced by Fujita in 1981 [7], addresses OSA at the oropharyngeal and retropalatal area [2,7–10]. Despite an 85–95% success rate in improving snoring, UPPP carries only a 40–50% success rate for OSA. In 1990, Kamami [11] introduced laser-assisted uvulopalatoplasty (LAUP) as a safe, effective outpatient alternative to UPPP. Although initially described for treatment of snoring, use of LAUP has now been extended to treatment of sleep apnea. Several reports have reported efficacy of LAUP for snoring and OSA [11–14]; however, the discrepancy between snoring and OSA results for standard UPPP raises the suspicion of similar findings in LAUP results. In this report we examine our results for LAUP based on objective as well as subjective measures of efficacy in the treatment of snoring and OSA.

MATERIALS AND METHODS

From January 1994 to January 1996, 297 patients were evaluated for snoring. All patients underwent a complete otolaryngologic evaluation and polysomnography (PSG). Apnea index (apneas/hour), hypopnea index (hypopneas/hour), and respiratory disturbance index [RDI = (apneas + hypopneas)/hour] were determined via the PSG. Patients were grouped into subpopulations based on RDI: ≤10—snoring without OSA; 11–20—mild OSA; 21–30—moderate OSA; >30—severe OSA. Of the 297 patients, 190 (64%) exhibited some degree of OSA documented by a PSG (see Fig. 1): 41/190 (22%) mild OSA; 33/190 (17%) moderate OSA; 85/190 (45%) severe OSA; 31/190 (16%) severity unknown. The unknown severity was due to inconclusive tests resulting from short durations of sleep that had been analyzed.

Surgical methods of treatment were offered to patients after standard nonsurgical methods failed to resolve snoring and OSA. Failures were attributed primarily to unsuccessful weight loss programs and/or noncompliance with CPAP.

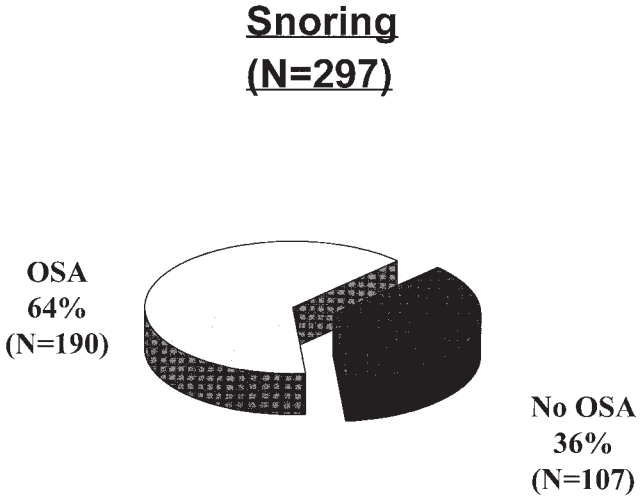

Fig. 1. Of 297 patients evaluated for snoring, PSG revealed 190 (64%) had some degree of sleep apnea.

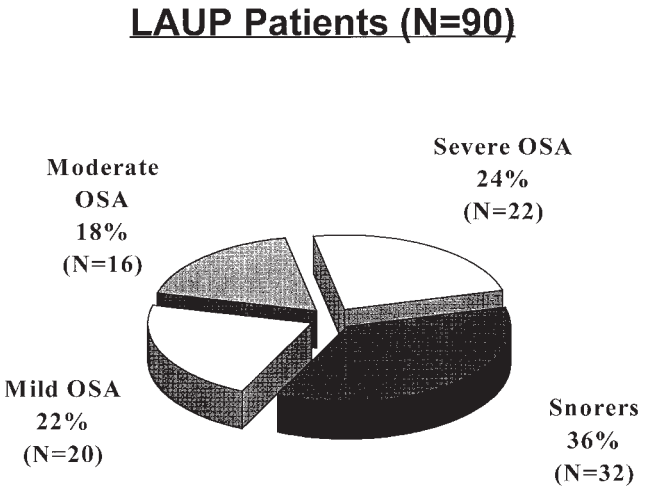

Fig. 2. Graphic representation of patients having undergone LAUP (n = 90) and the preparation of these patients according to degree of sleep apnea. Snorers = RDI ⩽ 10; Mild OSA = RDI of 11–20; Moderate OSA = RDI of 21–30; Severe OSA = RDI > 30.

CPAP was the preferred treatment for moderate and severe OSA; however, many patients refused CPAP intervention and requested LAUP. All patients were informed of the uncertainty of LAUP in treating OSA.

LAUP was performed on 90 patients, 58 (64%) of whom had some degree of OSA: 20/90 (22%) mild OSA; 16/90 (18%) moderate OSA; 22/90 (24%) severe OSA (see Fig. 2). Of the 90 LAUP patients, 72 (80%) were men and 18 (20%) were women. The mean age was 50 years: 50.5 for men and 48.5 for women. The mean body mass index (BMI = kg/m^2) was 28.6: 28.2 for men and 30.6 for women.

All LAUP patients completed a preoperative questionnaire (based on the Krespi questionnaire and used with permission) [15] that addressed their health status as well as the nature of their snoring and/or OSA. Patients described the historical factors of their sleep (i.e., precipitants, duration, frequency, loudness of snoring), previous treatments, and effect on their personal life (0–5 scale; 0 = none, 5 = extremely negative). Specific symptoms such as witnessed apneas, daytime somnolence, morning headaches, and decreased concentration were identified to establish any potential correlation between these symptoms and the presence and degree of OSA experienced. The questionnaire also provided information on tobacco use, alcohol consumption, and recent fluctuations in weight.

Polysomnograph Testing

Polysomnography (PSG) is the standard means to establish the presence and degree of OSA [16,17]. All polysomnograms were hospital based, overnight studies conducted in and analyzed by one of our sleep laboratories. Each patient's sleep was analyzed for the following variables: total apneas, total hypopneas, apnea index (AI), hypopnea index (HI), respiratory disturbance index (RDI), mean O_2 desaturation, lowest O_2 desaturation, mean duration of apnea, and longest duration of apnea.

LAUP Technique

LAUP was performed in an outpatient setting under local anesthesia, using topical benzocaine followed by soft palate and uvula injections with 1% lidocaine with 1:100,000 epinephrine mixed equally with 0.5% bupivicaine. A handheld CO_2 laser was used to resect a wedge or crescent of soft palate on each side of the uvula and then to ablate the uvula itself. Laser settings were 14–18 Watts, using the Sharplan Swiftlase™ system. Silver nitrate was applied in some cases for additional hemostasis. The palate was allowed to heal by secondary intention, and the next LAUP session was performed 4–6 weeks later. Typically, LAUP was performed over several sessions, with our endpoint being the patient's report of cessation of snoring or the patient's inability to create a palatal "snort" on office exam.

Postoperative Evaluation

Each patient was advised to have a follow-up examination within 2 months of completion of his/her last LAUP session. A complete head and neck examination was performed, and the patient was requested to have a postoperative PSG to determine objectively the effect of LAUP on OSA. Patients were also requested to complete a postoperative questionnaire to assess their sleep quality, rate their snoring condition following LAUP (1–7 scale: 1 = much worse, 4 = no change, 7 = much improved), and their satisfaction with LAUP (1–7 scale: 1 = very dissatisfied, 4 = neutral, 7 = very satisfied).

RESULTS

Ninety patients underwent LAUP, with 52 patients completing LAUP treatment and 20 undergoing postoperative polysomnograms. The preoperative and postoperative results were ana-

TABLE 1. Mean Preoperative Polysomnograph Results for Total LAUP Patients

Variables evaluated	Snorers (N = 32)	Mild OSA (N = 20)	Moderate OSA (N = 16)	Severe OSA (N = 22)	*P* Value
Sex (M;F)	25M; 7F	16M; 4F	13M; 3F	18M; 4 F	
Age (years)	47.13 ± 11.11	49.95 ± 6.99	49.75 ± 8.25	52.86 ± 11.76	0.24*
BMI (kg/m^2)	28.08 ± 3.44	28.98 ± 4.01	29.18 ± 4.15	28.02 ± 4.24	0.83*
Total apneas	5.0 ± 10.0	23.25 ± 22.33	46.23 ± 42.17	78.75 ± 100.1	<0.05*
Total hypopneas	21.46 ± 18.06	47.75 ± 31.05	106.0 ± 55.34	210.5 ± 117.5	<0.05*
Apnea index	0.83 ± 1.53	3.65 ± 3.53	7.17 ± 5.85	13.48 ± 15.48	<0.05*
Hypopnea index	3.33 ± 2.93	7.33 ± 4.28	15.76 ± 7.46	40.43 ± 20.77	<0.05*
RDI	4.22 ± 3.24	10.84 ± 4.50	22.91 ± 2.76	56.81 ± 24.39	<0.05*
Average O_2 desaturation (%)	94.4 ± 1.95%	92.93 ± 2.43%	92.52 ± 3.24%	90.52 ± 4.08%	<0.05*
Lowest O_2 desaturation (%)	89.68 ± 4.79%	85.64 ± 5.99%	84.91 ± 7.89%	83.32 ± 4.98%	<0.05*
Average duration of apneas (sec)	9.10 ± 8.98s	17.83 ± 6.99s	18.86 ± 6.76s	17.69 ± 6.55s	<0.05*
Longest duration of apnea (sec)	13.42 ± 19.30s	30.75 ± 13.83s	36.55 ± 17.64s	31.87 ± 20.20s	<0.05*

*Snorers vs. OSA (all groups); $P < 0.05$ (statistically significant).

lyzed for each subpopulation (as grouped by degree of apnea) and are shown on Tables 1 and 2, respectively.

Preoperative Results

Preoperative results are noted in Table 1.

Nonapneic snorers. Thirty-two patients (36%) were nonapneic snorers, 25 (78%) men and 7 (22%) women. The mean age was 47.13 years (s.d. ± 11.11, range 19–83), 47 years for men, 48 years for women. Mean BMI was 28.08 kg/m^2 (s.d. ± 3.44, range 22.4–35.4), 27.8 for men, 28.3 for women. Mean total apneas were 5.0 (s.d. ± 10.0, range 0–43), and mean total hypopneas were 21.46 (s.d. ± 18.06, range 0–71). Mean apnea index was 0.83 (s.d. ± 1.53, range 0–6.4); mean hypopnea index was 3.33 (s.d. ± 2.93, range 0–12.97); mean RDI was 4.22 (s.d. ± 3.24, range 0–12.97). Mean average O_2 desaturation was 94.4% (s.d. ± 1.95%, range 91–98.5%); mean lowest O_2 desaturation was 89.68% (s.d. ± 4.79%, range 83–95.9%). Mean average duration of apneas were 9.10 sec (s.d. ± 8.98 sec, range 0–25.8 sec); mean longest duration of apneas were 13.42 sec (s.d. ± 19.30 sec, range 0–85.2 sec).

Mild OSA. Twenty patients (22%) were diagnosed with mild OSA, 16 (80%) men and 4 (20%) women. The mean age was 49.95 years (s.d. ± 6.99, range 37–68), 52 years for men, 44 years for women. Mean BMI was 28.98 kg/m^2 (s.d. ± 4.01, range 23.5–41.9), 28.1 for men, 32.0 for women. Mean total apneas were 23.25 (s.d. ± 22.33, range 0–65), and total hypopneas were 47.75 (s.d. ± 31.05, range 4–98). Mean apnea index was 3.65 (s.d. ± 3.53, range 0–11.9); mean hypopnea index was 7.33 (s.d. ± 4.28, range 0.3–13.5); mean RDI was 10.84 (s.d. ± 4.50, range 4.2–18.7). Mean average O_2 desaturation was 92.93% (s.d. ± 2.43%, range 88.4–97.0%); mean lowest O_2 desaturation was 85.64% (s.d. ± 5.99%, range 71.8–92.0%). Mean average duration of apneas were 17.83 sec (s.d. ± 6.99 sec., range 0–30.4 sec.); mean longest duration of apneas were 30.75 sec (s.d. ± 13.83 sec, range 0–42.8 sec).

Moderate OSA. Sixteen patients (18%) were diagnosed with moderate OSA, 13 (81%) men and 3 (19%) women. Mean age was 49.75 years (s.d. ± 8.25, range 30–61), 51 years for men, 45 years for women. Mean BMI was 29.18 kg/m^2 (s.d. ± 4.15, range 23.9–38.7), 28 for men, 33 for women. Mean total apneas were 46.23 (s.d. ± 42.17, range 5.0–132), and mean total hypopneas were 106 (s.d. ± 55.34, range 17–188). Mean apnea index was 7.17 (s.d. ± 5.85, range 0.7–17.6); mean hypopnea index was 15.76 (s.d. ± 7.46, range 2.3–27.7); mean RDI was 22.91 (s.d. ± 2.76, range 19.6–29.0). Mean average O_2 desaturation was 92.52% (s.d. ± 3.24, range 85–97%); mean lowest O_2 desaturation was 84.91% (s.d. ± 7.89%, range 60–92.5%). Mean average duration of apneas were 18.86 sec (s.d. ± 6.76 sec, range 12–35.4 sec); mean longest duration of apneas were 36.55 sec (s.d. ± 17.64 sec, range 15–55 sec).

Severe OSA. Twenty-two patients (24%) were diagnosed with severe OSA, 18 (82%) men and 4 (18%) women. Mean age was 52.86 years (s.d. ± 11.76, range 32–76), 52 years for men, 57 years for women. Mean BMI was 28.02 kg/m^2 (s.d. ± 4.24, range 22.3–34.3), 28.0 for men, 29.0 for women. Mean total apneas were 78.75 (s.d. ± 100.1, range 3–312), and mean total hypopneas were 210.5 (s.d. ± 117.5, range 38–436). Mean apnea index was 13.48 (s.d. ± 15.48, range 0.6–56.9); mean hypopnea index was 40.43 (s.d. ± 20.77, range 5.1–95.5); mean RDI was 56.81 (s.d. ± 24.39, range 30–111). Mean average O_2 desatura-

TABLE 2. Mean Postoperative Polysomnograph Results

Variables evaluated	Snorers (N = 3)	Mild OSA (N = 7)	Moderate OSA (N = 5)	Severe OSA (N = 5)
Total apneas	6.3	12.6	65.8	74.4*
Total hypopneas	56.0	97.0	87.2	164.6
Apnea index	1.0	2.0	9.5	14.5
Hypopnea index	8.3	17.5	16	31.7*
RDI	9.3	19.5	25.4	46.3*
Average O_2 desaturation (%)	94.9	92.6	91.5	90.3
Lowest O_2 desaturation (%)	90.3	84.5	84.4*	84.6
Average duration of apneas (sec)	11.7*	16.1	19.4	16.2
Longest duration of apnea (sec)	18.0*	25.9	50.6	30.2
Number of LAUP sessions	2.5 ± 0.67	2.43 ± 0.85	2.5 ± 0.97	2.88 ± 1.71

*$P < 0.05$ indicates statistical significance for change from preoperative results.

tion was 90.52% (s.d. ± 4.08%, range 79–96%); mean lowest O_2 desaturation was 83.32% (s.d. ± 4.98%, range 71.3–91%). Mean average duration of apneas were 17.69 sec (s.d. ± 17.69 sec, range 12–39 sec); mean longest duration of apneas were 31.87 sec (s.d. ± 20.2 sec., range 14–78.8 sec).

Postoperative Results

For postoperative results, see Tables 2 and 3.

Nonapneic snorers. Three nonapneic snorers that completed LAUP underwent postoperative PSGs. The mean number of LAUP sessions was 2.5 (s.d. ± 0.67). Mean total apneas increased from 5.0 to 6.3 ($P = 0.27$), and mean total hypopneas increased from 21.46 to 56.0 ($P = 0.28$). Mean apnea index increased from 0.83 to 1.0 ($P = 0.95$). Mean hypopnea index also increased from 3.3 to 8.3 ($P = 0.24$). Mean RDI increased from 4.2 to 9.3 ($P = 0.27$). Mean average O_2 desaturation increased from 94.4% to 94.9% ($P = 0.06$), and mean lowest O_2 desaturation increased from 89.7% to 90.3% ($P = 0.46$). Mean average duration of apneas increased from 9.1 sec to 11.7 sec ($P < 0.05$). Mean longest duration of apneas increased from 13.42 sec to 18.0 sec ($P < 0.05$).

Twelve of the 52 completed patients were nonapneic snorers. Nine patients (75%) indicated moderate-much improvement in their snoring condition. Two patients (17%) reported no change. One patient (8%) indicated that snoring became much worse (see Table 4). Ten patients (83%) were moderate-very satisfied with LAUP, whereas 2 patients (17%) were very dissatisfied (see Table 5).

Mild OSA. Seven patients with mild OSA that completed LAUP treatment underwent postoperative PSGs. The mean number of LAUP sessions was 2.43 (s.d. ± 0.85). Mean total apneas decreased from 23.25 to 12.6 ($P = 0.51$), and mean total hypopneas increased from 47.75 to 97.0 ($P = 0.18$). Mean apnea index decreased from 3.65 to 2.0 ($P = 0.48$). Mean hypopnea index increased from 7.33 to 17.5 ($P = 0.18$). Mean RDI increased from 10.84 to 19.5 ($P = 0.14$). Mean average O_2 desaturation decreased from 92.9% to 92.6% ($P = 0.21$). Mean lowest O_2 desaturation decreased from 85.6% to 84.5% ($P = 0.68$). Mean average duration of apneas decreased from 17.83 to 16.1 sec ($P = 0.64$). Mean longest duration of apneas decreased from 30.75 to 25.9 sec ($P = 0.24$).

Fourteen of the 52 completed patients were diagnosed with mild OSA. Ten patients (71%) reported moderate-much improvement in their snoring condition. Four patients (29%) indicated no change in snoring (see Table 4). Ten patients (71%) were moderate-very satisfied with LAUP. Two patients (14.5%) revealed neutral response. Two patients (14.5%) were very dissatisfied with LAUP (see Table 5).

Moderate OSA. Five patients with moderate OSA that completed LAUP treatment underwent postoperative PSGs. The mean number of LAUP sessions was 2.5 (s.d. ± 0.97). Mean total apneas increased from 46.23 to 65.8 ($P = 0.61$), and mean total hypopneas decreased from 106 to 87.2 ($P = 0.61$). Mean apnea index increased from 7.17 to 9.5 ($P = 0.55$); hypopnea index increased from 15.8 to 16.0 ($P = 0.18$). Mean RDI increased from 22.9 to 25.4 ($P = 0.43$). Mean average O_2 desaturation decreased from 92.5% to 91.5% ($P = 0.79$). Mean lowest O_2 desaturation decreased from 84.9% to 84.4% ($P < 0.05$). Mean average duration of apneas increased from 18.86 to 19.4 sec ($P = 0.11$). Mean longest duration of apneas increased from 36.55 to 50.6 sec ($P = 0.35$).

Ten of the 52 completed patients were diagnosed with moderate OSA. Three patients (30%)

TABLE 3. Comparison of Preoperative vs. Postoperative Polysomnograph Data

Variables evaluated	Snorers (N = 3)	Mild OSA (N = 7)	Moderate OSA (N = 5)	Severe OSA (N = 5)
Apnea index (AI)				
pre-op	0.83	3.65	7.17	13.5
post-op	1.00	2.00	9.50	14.5
Hypopnea index (HI)				
pre-op	3.30	7.30	15.8	40.4
post-op	8.30	17.5	16.0	31.7*
RDI				
pre-op	4.20	10.8	22.9	56.8
post-op	9.30	19.5	25.4	46.3*
Mean O_2 desaturation (%)				
pre-op	94.4	92.9	92.5	90.5
post-op	94.9	92.6	91.5	90.3
Lowest O_2 desaturation (%)				
pre-op	89.7	85.6	84.9	83.3
post-op	90.3	84.5	84.4*	84.6

*$P < 0.05$ indicates statistical significant change from preoperative value.

TABLE 4. Postoperative Data: Patients Status of Snoring

	Snorers (N = 12)	Mild OSA (N = 14)	Moderate OSA (N = 10)	Severe OSA (N = 16)
Improved (%)	75	71	30	37
No change (%)	17	29	60	63
Worse (%)	8	0	10	0

TABLE 5. Postoperative Data: Patient Satisfaction With LAUP

	Snorers (N = 12)	Mild OSA (N = 14)	Moderate OSA (N = 10)	Severe OSA (N = 16)
Satisfied (%)	83	71	30	44
Neutral (%)	0	14.5	60	31
Dissatisfied (%)	17	14.5	10	25

indicated moderate-much improvement in their snoring condition. Six patients (60%) reported no change in snoring. One patient (10%) indicated that snoring became much worse (see Table 4). Three patients (30%) were moderately-very satisfied with LAUP. Six patients (60%) expressed a neutral response. One patient (10%) was very dissatisfied with LAUP (see Table 5).

Severe OSA. Five patients with severe OSA that completed LAUP treatment underwent postoperative PSGs. The mean number of LAUP sessions was 2.88 (s.d. ± 1.71). Mean total apneas decreased from 78.75 to 74.4 ($P < 0.05$), and mean total hypopneas decreased from 210.5 to 164.6 ($P = 0.14$). Mean apnea index increased from 13.5 to 14.5 ($P = 0.13$). Mean hypopnea index decreased from 40.4 to 31.7 ($P < 0.05$). Mean RDI decreased from 56.8 to 46.3 ($P < 0.05$). Mean average O_2 desaturation decreased from 90.5% to 90.3% ($P = 0.47$). Mean lowest O_2 desaturation increased from 83.3% to 84.6% ($P = 0.48$). Mean average duration of apneas decreased from 17.69 to 16.2 sec ($P = 0.19$). Mean longest duration of apneas decreased from 31.87 to 30.2 sec ($P = 0.74$).

Sixteen of the 52 completed patients were diagnosed with severe OSA. Six patients (37%) indicated moderate-much improvement in their snoring condition. Ten patients (63%) reported no change in snoring (see Table 4). Seven patients (44%) were moderately-very satisfied with LAUP. Five patients (31%) expressed a neutral response. Four patients (25%) were very dissatisfied with LAUP (see Table 5).

DISCUSSION

Habitual, loud snoring is increasingly recognized as a serious problem for many individuals. Beyond its obvious social ramifications, snoring may indicate the presence of obstructive sleep apnea (OSA). The prevalence of OSA, defined as an RDI of 10 or greater, is estimated to be up to 4% in men and 2% in women [18]. OSA poses significant health risks including hypertension, cardiac arrhythmic, stroke and increased mortality [3]. Most patients seek therapy primarily for the snoring aspect of their sleep disorder. The clinician must subsequently ascertain whether such snoring is isolated or is in fact a sign of clinically significant OSA. This determination will influence eventual treatment decisions, particularly in light of treatments that may cure snoring without af-

fecting OSA [7]. Patients will often desire treatments that appear to be simple or "cutting edge" despite a lack of verified clinical efficacy.

The incidence of OSA in patients with loud snoring has been identified at 38% [13] to 73% [18]. Our study indicated that 64% of snorers had OSA. Additionally, frequently identified historical factors such as morning headaches, decreased concentration, daytime somnolence, and even witnessed apneas did not adequately predict the presence of OSA. This fact has been seen elsewhere in the literature [18]. For this reason, polysomnography is necessary prior to treatment of habitual snorers, and obtaining a pretreatment PSG should continue to be the standard care for such patients.

Laser-assisted uvulopalatoplasty can be considered an effective treatment for nonapneic snoring. Several studies support success rates in the 60–92% range [11–14]. Our results indicate a success rate of 75%, which in our population consisted of complete or near-complete resolution of snoring. This is comparable to other published data with respect to nonapneic snoring [11–14]. However, our patients with only partial resolution reported that snoring was still problematic and were therefore dissatisfied (Tables 4 and 5), unlike prior studies that reported more satisfied groups of partial responders [11–14]. Our results with snoring may be explained by our inclusion of patients with all types of upper airway anatomy involving elongation of the palate and uvula; thus patients with retrognathia, macroglossia, lateral pharyngeal collapse, and nasal obstruction were not excluded. We suspect excluding such patients would yield a much higher rate of snoring resolution.

Our results for snoring in apneic patients reveal LAUP to have diminishing efficacy as severity of apnea increases, ranging from 71% success in mild OSA to only 37% in severe OSA. These results are indicative of the more collapsible airway in patients with OSA and may indicate that the snoring as well as the OSA is due to collapse at several levels of the upper respiratory tract. The OSA patients that responded positively with regard to their snoring may have been converted from symptomatic "snoring" obstructive sleep apnea patients to asymptomatic "nonsnoring" obstructive sleep apnea patients.

The use of palatal surgery for OSA has been widespread and was popularized by Fujita et al. [7] in 1981 with the standard uvulopalatopharyngoplasty (UPPP). However, even UPPP results in only a 40–50% success rate for OSA despite 85–95% rates for snoring; in fact, UPPP may be most efficacious on patients with mild OSA only. Laser-assisted uvulopalatoplasty has emerged as a safer, simpler version of UPPP, boasting equivalent results for snoring and OSA. Kamami reported a 77% complete resolution and 23% partial resolution of snoring [11], whereas Krespi reported 86% and 7% for complete and partial resolution, respectively [15]. In the treatment of OSA, Walker et al. reported a 48% success rate based on pre- and postoperative PSGs [13]. Mickelson reported a reduction in apnea index (AI) from 19.4 to 4.2 and in RDI from 31.2 to 15.7, with RDI reduced by at least half in 53.8% of his patients [14]. Terris et al. [19] reported an initial worsening of AI and RDI as well as a reduction of airway cross-sectional area within 2–3 days after LAUP, raising the question of a negative effect of the procedure.

This study shows little or no benefit from LAUP for OSA. No statistically significant improvements were obtained in mild and moderate apneic patients, and some parameters were seen to worsen. Severe apneics showed a modest yet statistically significant decrease in RDI; however, the postoperative mean RDI of 46.3 still rendered these patients clinically significant apneics requiring further therapy. Thus we conclude that LAUP has no efficacy in achieving a clinically significant reduction in OSA.

Based on our results, we believe LAUP to be a reasonable treatment for snoring in patients who are nonapneic snorers. There is also benefit in resolution of snoring for patients with mild OSA. If patients are carefully selected, we anticipate improvement in success rates for snoring in these two groups. However, based on these findings, we do not support LAUP as a sole upper airway treatment for OSA. LAUP may be useful as an adjunctive procedure within a broader treatment plan: reduction of RDI in severe apneics to allow lower CPAP pressure; shortening of the palate to improve the efficacy of dental sleep apnea appliances; conservative resection of the palate combined with orthognathic procedures. We suspect that the effect of palatal tightening seen with LAUP may actually result in overall narrowing of the airway, thus offsetting the benefit achieved from palatal shortening and therefore having little effect on RDI. Additionally, we support the concern that LAUP may convert symptomatic "snoring" OSA patients to asymptomatic "nonsnoring" OSA patients.

Conclusion

Snoring carries not only poor social ramifications but also the significant possibility of obstructive sleep apnea with its associated morbidity and mortality. Evaluation of the snoring patient requires careful attention to the structure of the upper airway and must include a polysomnogram as the only reliable means to assess for OSA. LAUP may be efficacious for snoring in nonapneic and mild apneic snorers but shows little promise as a sole treatment for OSA. LAUP may be considered as an adjunct to other modalities of treatment for OSA. Resolution of snoring in OSA patients via LAUP may actually "mask" continued episodes of obstruction.

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